

WHAT IS CLAIMED IS:

1. A temperature sensor, comprising:

a comparator circuit having an output node and a variable current node, wherein the output node is a first voltage at a given temperature when a current at the variable current node is less than a threshold current, and a different second voltage at the given temperature when the current at the variable current node is more than the threshold current;

a variable resistance circuit including at least  $n$  resistors connected in series between the variable current node of the comparator and a reference voltage, where  $n$  is an integer of 4 or more, and wherein the  $n$  resistors have different resistance values; and

a switching circuit which selectively bypasses individual ones of the  $n$  resistors.

2. The temperature sensor of claim 1, wherein one resistor among the  $n$  resistors has a lowest resistance value, and wherein the remaining resistors among the  $n$  resistors have resistance values which are multiples of the resistance value of the lowest resistance value.

3. The temperature sensor of claim 1, wherein one resistor  $R_1$  among the  $n$  resistors has a lowest resistance

value  $x$ , and wherein the remaining resistors  $R_2, R_3, \dots, R_n$  resistors among the  $n$  resistors have resistance values of  $x \cdot 2, x \cdot 4, \dots, x \cdot (2^{n-1})$ , respectively.

5           4. The temperature sensor of claim 1, wherein the switching circuit comprises at least  $n$  transistors connected across respective ones of the  $n$  resistors, wherein gate terminals of the  $n$  transistors are responsive to an input test signal to selectively bypass the  $n$  resistors,  
10           respectively.

          5. The temperature sensor of claim 2, wherein the switching circuit comprises at least  $n$  transistors connected across respective ones of the  $n$  resistors, wherein gate  
15           terminals of the  $n$  transistors are responsive to an input test signal to selectively bypass the  $n$  resistors,  
          respectively.

          6. The temperature sensor of claim 3, wherein the  
20           switching circuit comprises at least  $n$  transistors connected across respective ones of the  $n$  resistors, wherein gate terminals of the  $n$  transistors are responsive to an input test signal to selectively bypass the  $n$  resistors,  
          respectively.

7. A temperature sensor, comprising:

a comparator circuit having an output node and a variable current node, wherein the output node is a first voltage at a given temperature when a current at the variable current node is less than a threshold current, and a different second voltage at the given temperature when the current at the variable current node is more than the threshold current;

first and second variable resistance circuits connected in series between the variable current node of the comparator and a supply voltage, wherein the first variable resistance circuit includes  $n$  resistors connected in series, where  $n$  is an integer of 4 or more and the  $n$  resistors have different resistance values, and wherein the second variable resistance circuit includes  $m$  resistors connected in series, where  $m$  is an integer of 4 or more and the  $m$  resistors have different resistance values;

a first switching circuit which selectively bypasses individual ones of the  $n$  resistors of the first variable resistance circuit; and

a second switching circuit which selectively bypasses individual ones of the  $m$  resistors of the second variable resistance circuit.

8. The temperature sensor of claim 7, wherein  $m$  equals

n, and wherein resistance values of the m transistors of the first variable resistance circuit are respectively the same as resistance values of the n transistors of the second variable resistance circuit.

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9. The temperature sensor of claim 8, wherein one resistor among the n resistors has a lowest resistance value, and wherein the remaining resistors among the n resistors have resistance values which are multiples of the resistance value of the lowest resistance value.

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10. The temperature sensor of claim 8, wherein one resistor  $R_1$  among the n resistors has a lowest resistance value x, and wherein the remaining resistors  $R_2, R_3, \dots, R_{n-1}$  resistors among the n resistors have resistance values of  $x \cdot 2, x \cdot 4, \dots, x \cdot (2^{n-1})$ .

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11. The temperature sensor of claim 7, wherein the first switching circuit comprises at least m transistors connected across respective ones of the m resistors, wherein gate terminals of the m transistors are responsive to a first input test signal to selectively bypass the m resistors, respectively, and wherein the second switching circuit comprises at least n transistors connected across respective ones of the n resistors, wherein gate terminals

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of the  $n$  transistors are responsive to a second input test signal to selectively bypass the  $n$  resistors, respectively.

12. The temperature sensor of claim 8, wherein the  
5 first switching circuit comprises at least  $m$  transistors  
connected across respective ones of the  $m$  resistors, wherein  
gate terminals of the  $m$  transistors are responsive to a  
first input test signal to selectively bypass the  $m$   
resistors, respectively, and wherein the second switching  
10 circuit comprises at least  $n$  transistors connected across  
respective ones of the  $n$  resistors, wherein gate terminals  
of the  $n$  transistors are responsive to a second input test  
signal to selectively bypass the  $n$  resistors, respectively.

15 13. The temperature sensor of claim 9, wherein the  
first switching circuit comprises at least  $m$  transistors  
connected across respective ones of the  $m$  resistors, wherein  
gate terminals of the  $m$  transistors are responsive to a  
first input test signal to selectively bypass the  $m$   
20 resistors, respectively, and wherein the second switching  
circuit comprises at least  $n$  transistors connected across  
respective ones of the  $n$  resistors, wherein gate terminals  
of the  $n$  transistors are responsive to a second input test  
signal to selectively bypass the  $n$  resistors, respectively.

14. The temperature sensor of claim 10, wherein the first switching circuit comprises at least  $m$  transistors connected across respective ones of the  $m$  resistors, wherein gate terminals of the  $m$  transistors are responsive to a first input test signal to selectively bypass the  $m$  resistors, respectively, and wherein the second switching circuit comprises at least  $n$  transistors connected across respective ones of the  $n$  resistors, wherein gate terminals of the  $n$  transistors are responsive to a second input test signal to selectively bypass the  $n$  resistors, respectively.

15. The temperature sensor of claim 11, further comprising a trimming circuit connect in parallel to the first variable resistance circuit, wherein the trimming circuit includes a second set of  $m$  transistors connected across the  $m$  resistors of the first variable resistance circuit, respectively, and  $m$  latch circuits which selectively latch the gates of the second set of  $m$  transistors to a high voltage.

16. The temperature sensor of claim 12, further comprising a trimming circuit connect in parallel to the first variable resistance circuit, wherein the trimming circuit includes a second set of  $m$  transistors connected across the  $m$  resistors of the first variable resistance

circuit, respectively, and m latch circuits which selectively latch the gates of the second set of m transistors to a high voltage.

5           17. The temperature sensor of claim 13, further comprising a trimming circuit connect in parallel to the first variable resistance circuit, wherein the trimming circuit includes a second set of m transistors connected across the m resistors of the first variable resistance  
10 circuit, respectively, and m latch circuits which selectively latch the gates of the second set of m transistors to a high voltage.

15           18. The temperature sensor of claim 14, further comprising a trimming circuit connect in parallel to the first variable resistance circuit, wherein the trimming circuit includes a second set of m transistors connected across the m resistors of the first variable resistance  
20 circuit, respectively, and m latch circuits which selectively latch the gates of the second set of m transistors to a high voltage.

25           19. The temperature sensor of claim 7, further comprising a third variable resistance circuit connected in series with the first and second variable resistance

circuits, wherein the third variable resistance circuit includes p resistors connected in series, where p is an integer of 4 or more and the p resistors have different resistance values, and p fuses respectively connected across the p resistors.

20. The temperature sensor of claim 19, wherein p equals m equals n, and wherein resistance values of the p transistors of the third variable resistance circuit are respectively the same as resistance values of the m transistors of the first variable resistance circuit and the n transistors of the second variable resistance circuit.

21. A temperature sensor, comprising:

a comparator circuit having an output node and a variable current node, wherein the output node is a first voltage at a given temperature when a current at the variable current node is less than a threshold current, and a different second voltage at the given temperature when the current at the variable current node is more than the threshold current;

a variable resistance circuit including a plurality of resistors connected in series; and

a trimming circuit which selectively electrically connects or disconnects individual ones of the resistors of

variable resistance circuit to the variable current node.

22. The temperature sensor of claim 21, wherein the trimming circuit includes a plurality of fuses respectively corresponding to the plurality of resistors.

23. The temperature sensor of claim 21, wherein one resistor  $R_1$  among the plurality of resistors has a lowest resistance value  $x$ , and wherein the remaining resistors  $R_2$ ,  $R_3$ , ... ,  $R_n$  resistors among the plurality of resistors have resistance values of  $x \cdot 2$ ,  $x \cdot 4$ , ... ,  $x \cdot (2^{n-1})$ , respectively.

24. A method of determining a trip temperature of a temperature sensor, the temperature sensor having (a) a comparator circuit having an output node and a variable current node, wherein the output node is a first voltage at a given temperature when a current at the variable current node is less than a threshold current, and a different second voltage at the given temperature when the current at the variable current node is more than the threshold current, and (b) a variable resistance circuit connected in series between the variable current node of the comparator and a reference voltage, said method comprising:

fixing a temperature of the temperature sensor to a reference temperature;

varying a resistance of the variable resistance circuit to determine a difference between an initial resistance and a resistance at which the output node of the comparator oscillates between the first and second voltages, said  
5 difference corresponding to a change in trip temperature of the sensor;

calculating the trip temperature according to the reference temperature and the change in trip temperature of the sensor.

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25. The method of claim 24, further comprising setting the variable resistance circuit to the initial resistance, and conducting a trimming operation to changed the calculated trip temperature to a target trip temperature.

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26. The method of claim 24, wherein the resistance of the variable resistance circuit is varied according to a binary weighted approximation method.

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27. A method of determining a trip temperature of a temperature sensor, the temperature sensor having (a) a comparator circuit having an output node and a variable current node, wherein the output node is a first voltage at a given temperature when a current at the variable current  
25 node is less than a threshold current, and a different

second voltage at the given temperature when the current at the variable current node is more than the threshold current,

(b) a variable resistance circuit including at least resistors  $R_1, R_2, \dots R_n$  which are selectively connected in

5 series between the variable current node of the comparator and a supply voltage, where  $n$  is an integer of 4 or more, and wherein  $R_1 < R_2, \dots R_{n-1} < R_n$ , said method comprising:

fixing a temperature of the temperature sensor to a first temperature, and electrically connecting the resistors  
10  $R_1, R_2, \dots R_n$  in series between the variable current node of the comparator and a supply voltage;

conducting a test sequence in which the output node of the comparator of the comparator is monitored while the resistor  $R_n$  is bypassed between the variable current node of  
15 the comparator and the supply voltage, and in which the resistor  $R_n$  is set to be electrically connected between the variable current node and the supply voltage if the output node of the comparator is the first voltage, and the resistor  $R_n$  is set to be bypassed between the variable  
20 current node and the supply voltage if the output node of the comparator is the second voltage;

repeating the test sequence for each of the remaining resistors  $R_{n-1}$  to  $R_1$  in order; and

upon completion of the final test sequence for the  
25 resistor  $R_1$ , determining a trip resistance of the temperature

sensor as a difference between the first temperature and an adjustment temperature corresponding to a total value of the resistors  $R_1, R_2, \dots R_n$  which were set to be connected between the variable current node and the supply voltage.

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28. The method as claimed in claim 27, wherein resistor  $R_1$  among the  $n$  resistors has a resistance value  $x$ , and wherein the remaining resistors  $R_2, R_3, \dots, R_n$  resistors among the  $n$  resistors have resistance values of  $x \cdot 2, x \cdot 4, \dots, x \cdot (2^{n-1})$ , respectively.

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29. The method of claim 28, wherein the resistance of the variable resistance circuit is varied according to a binary weighted approximation method.

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30. A method of determining a trip temperature of a temperature sensor, the temperature sensor having (a) a comparator circuit having an output node and a variable current node, wherein the output node is a first voltage at a given temperature when a current at the variable current node is less than a threshold current, and a different second voltage at the given temperature when the current at the variable current node is more than the threshold current, and (b) a variable resistance circuit connected in series between the variable current node of the comparator and a

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reference voltage, said method comprising:

conducting a first test which includes (a) fixing a temperature of the temperature sensor to a first reference temperature, and (b) increasing a resistance of the variable resistance circuit to determine a difference between an initial resistance and a resistance at which the output node of the comparator oscillates between the first and second voltages, said difference corresponding to a first change in trip temperature of the sensor;

conducting a second test which includes (a) fixing a temperature of the temperature sensor to a second reference temperature, and (b) decreasing a resistance of the variable resistance circuit to determine a difference between an initial resistance and a resistance at which the output node of the comparator oscillates between the first and second voltages, said difference corresponding to a second change in trip temperature of the sensor;

calculating the trip temperature according to the first and second reference temperatures and the first and second changes in trip temperature of the sensor.

31. The method of claim 30, further comprising setting the variable resistance circuit to the initial resistance, and conducting a trimming operation to change the calculated trip temperature to a target trip temperature.

32. The method of claim 30, wherein the resistance of the variable resistance circuit is increased in the first test according to a binary weighted approximation method.

5           33. The method of claim 30, wherein the resistance of the variable resistance circuit is decreased in the second test according to a binary weighted approximation method.